RELATIONS AMONG OBESITY, ADULT WEIGHT STATUS AND CANCER IN US ADULTS

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Background

The number of cancer cases is progressively rising in America. The American Cancer Society has reported the number of cases per year which shows this steady increase. In 2005, the number of cancer cases was an estimate, 1.37 million. In 2006, the number grew to 1.4 million, and climbed to approximately 1.45 million in 2007 (1). The cause of this rise in cases may be linked to the increase in obesity.

America's average weight is also increasing and it is now reported that approximately two-thirds of all Americans are overweight or obese. Today, 66.3% of Americans over the age of 20 are overweight, while 32.2% of Americans are considered obese. To compare, data collected from NHANES in 2001-02 revealed that 65.7% of Americans were overweight, and 30.6% of those Americans were obese (3). The criteria for diagnosing someone as overweight or obese is based on their calculated body mass-index (BMI) which is calculated as weight in kilograms/(height in meters)^2. Overweight is categorized as a BMI of 25.0-29.9, and obese is categorized as a BMI over 30.0.

There are lifestyle behaviors that have been associated with the incidence of cancer which includes diet, physical activity, and obesity. One such dietary related cancer prevention behavior is the consumption of fruits and vegetables which has been shown to play a role in lung, esophageal, stomach, and colorectal cancer prevention. Evidence has also shown that intake of red or processed meats increases the risk for cancer (2). Physical activity has been shown to reduce the risk in cancers of the breast, colon, prostate, and endometrium (2). This reduced risk may result from direct and/or

indirect mechanisms such as hormone regulation and weight reduction. Also, obesity has been show to be related to the cancer process.

In the United States, overweight and obesity contributes to 14-20% of all cancer related mortalities (2). Cancers that have been clearly related to obesity include cancers of the colon, endometrium, adenocarcinoma of the esophagus, kidney, and breast in postmenopausal women. There has been convincing evidence of an association of obesity with cancers of the pancreas, gallbladder, thyroid, ovary, prostate, cervix, multiple myeloma, and Hodgkin lymphoma (2). It has been posited that greater than 90,000 deaths per year could be prevented if all US adults maintained a BMI under 25.0 throughout their adulthood (3).

To explore the relationship between adulthood obesity patterns and risk for obesity-related cancers, we examined adult weight gain patterns among those with a diagnosis of obesity-related cancers compared to those with non-obesity related cancers and no cancer history. We used data from the National Health and Nutrition Examination Survey (NHANES) to explore these patterns. The first specific aim was to determine if there is a difference in obesity (BMI) patterns in those with a diagnosis of obesity-related cancers to those with non-obesity related cancers or no cancer history. The second specific aim was to determine if there was a difference in adult weight gain patterns between those same groups in the time frame of; since 25 years of age, since 10 years ago, since 1 year ago, and since their heaviest weight.

Methods

To examine the relationship of obesity (BMI), and adult weight gain to cancer, statistics from the 1999-2004 National Health and Nutrition Examination Survey (NHANES) were used. NHANES is a stratified, multi-staged national nutrition monitoring survey which used probability sampling of the civilian, non-institutionalized US population, collected by the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention (CDC) to evaluate the health and nutritional status of the civilian, non-institutionalized population of the United States. To improve the representation of underserved groups, the aged (>60 years), adolescents (12-19 years), African and Hispanic Americans, pregnant women and low-income persons were purposely over-sampled. The NHANES interview includes demographic, socioeconomic, dietary, and health-related questions. The examination portion includes medical and dental examinations, physiological measurements and laboratory tests (4).

Public use data files were downloaded from the NHANES website and imported into SPSS (version 15.0, SPSS, Chicago, IL) for analysis. The selected sample for this study was adults over the age of 45 with measured heights and weights, a completed weight history questionnaire and the medical conditions questionnaire. The number of individuals that were included totaled 8,703.

Data used in the analyses were collected from self-reported questionnaires at the Mobile Examination Center. Weight history data was collected in the specific areas of current weight, heaviest weight, weight 1 and 10 years ago, and weight at the age of 25 years. Changes in body weight (lbs.) were obtained from heaviest weight, weight 1 year

ago, weight 10 years ago, and weight at 25 years old to the current weight (computed: i.e. current weight – weight 1 year ago). BMI data was calculated using current height and the self reported weight data from heaviest weight, current weight, weigh 1 and 10 years ago, and weight at the age of 25 years. This assumed that height has changed little since 25 years of age and allowed for the overall assessment of obesity changes over time. We recoded individuals into an obesity-related cancer group, a non obesity-related cancer group, and those with no cancer history.

History of medical conditions was self-reported during the medical conditions questionnaire. Self-reported cancer history was collected by the individual identifying if they have ever been told that they have cancer. If they did have cancer, then the specific cancer was reported. Obesity-related cancers are identified from the list of cancers diagnosed which includes cancers of the breast, colorectal, cervix, endometrial, pancreatic, prostate, gallbladder, ovarian, esophagus, kidney, thyroid, multiple myeloma, and Hodgkin's disease.

Data Analysis

We analyzed this nationally representative sample to identify differences in weight status and adult weight change across types of cancer. To compare current weight status of individuals across cancer diagnosis groups, analysis of variance (ANOVA) was computed for mean values of current weight and current BMI across cancer groups. To examine the differences in adult weight changes by cancer diagnosis groups (RQ2), mean differences were compared for changes in weight from heaviest weight, 1 year ago, 10 years ago, and from age 25 by ANOVA.

This data were tabulated for analysis using SPSS (version 15.0). All analyses were conducted using the SPSS Complex Samples (version 15.0) to account for the stratified, multi-staged sampling technique used in subject selection.

Results

Differences in various weight gain patterns and weight status were researched between three categories; adults with obesity-related cancer, adults with non-obesity related cancer, and adults with no cancer history. To examine the relationship between weight history and the rates of obesity related cancers, mean differences were explored for individuals with and without cancer. From the NHANES sample, 5.4% (n=558) and 5.4% (n=435) of the sample (total = 8,703) reported an obesity and non-obesity-related cancer history, respectively, while 89.3% (n=7,710) had no cancer history. Women were more likely to present with obesity-related cancer than males (6.8% vs. 4.0%).

The figure below provides the proportion of individuals who were overweight or obese by cancer history. Over one third of all participants in each cancer group were overweight; however, those with a history of non-obesity-related cancer were less likely to be obese. Sixty-eight percent of those with an obesity-related cancer history were overweight or obese at the time of measurement.

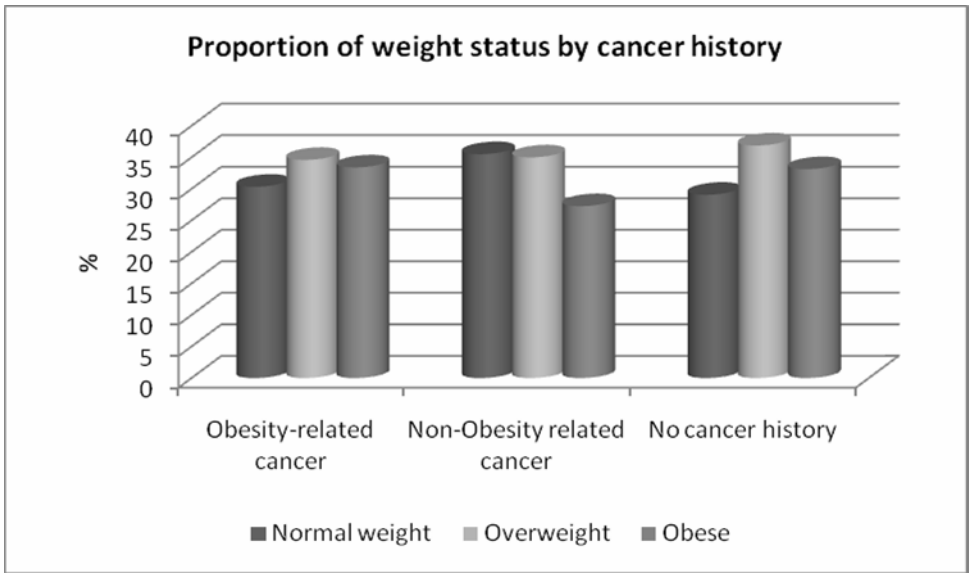

Figure 1. Proportion of current weight status by cancer history

There were a number of significant differences found in the male sample (Table 1). Those with obesity-related cancers over-estimated their weight to a greater extent than those with non-obesity related cancer. This was found by dividing their current self-reported weight by their actual current weight. Those with no cancer history had significantly greater annual weight change since the age of 25 and over the past 10 years than participants with previous cancer history. Men with obesity- and non-obesity related cancer histories were at a significantly lower percentage of their heaviest body weights than those with no cancer history.

As for females, two significant differences in history were found. In the area of annual weight change in pounds since age 25, women with non-obesity related cancer history had a significantly lower annual weight increase than those with no cancer history. In the area of current percentage of heaviest weight, a small but significant difference was found between with obesity-related cancer and no cancer history.

Gender	Weight History	Obesity-related cancer Mean (SE)[1]	Non-Obesity related cancer Mean (SE)[1]	No cancer history Mean (SE)[1]
Male	Current weight -measured (lbs)	187.76 (2.92)	192.92 (2.89)	193.71 (0.91)
	Current Self-reported weight (lbs)	189.41 (2.9)	192.87 (2.8)	194.41 (0.9)
	Percent of self-reported weight (%)	101.13 (0.22)[a]	100.25 (0.17)[b]	100.58 (0.08)[ab]
	Self-reported weight at age 25 (lbs)	162.98 (2.41)	168.95 (1.88)	168.18 (0.78)
	Annual weight change since age 25 (lbs)	0.63 (0.07)[a]	0.77 (0.08)[a]	1.14 (0.03)[b]
	Self-reported weight-10 yrs ago (lbs)	185.62 (2.73)	187.61 (1.99)	183.79 (0.83)
	Annual weight change over last 10 years (lbs)	0.38 (1.76)[a]	0.54 (1.76)[a]	1.06 (0.47)[b]
	Weight change last 10 years (% of previous)	2.23 (0.97)[a]	3.06 (0.93)[a]	6.33 (0.24)[b]
	Self-reported weight-1 yr ago (pounds)	190.48 (2.86)	196.02 (3.21)	195.08 (0.93)
	Weight change in last year (lb)	-0.48 (0.48)	-1.08 (0.38)	-0.02 (0.13)
	Weight change in last year (% of previous)	-1.07 (0.93)	-3.01 (0.92)	-0.65 (0.28)
	Self-reported greatest weight(pounds)	207.43 (2.75)	210.94 (3.01)	208.56 (1)
	Percent of heaviest weight	0.91 (0.01)[a]	0.92 (0.01)[a]	0.94 (0)[b]
Female	Current weight -measured (lbs)	161.5 (2.86)	161.09 (4.36)	165.02 (1.05)
	Current Self-reported weight (lbs)	160.15 (2.76)	159.55 (4.31)	162.83 (1.04)
	Percent of self-reported weight (%)	99.5 (0.29)	99.17 (0.2)	98.87 (0.1)
	Self-reported weight at age 25 (lbs)	130.08 (1.69)	128.13 (2.34)	130.66 (0.68)
	Annual weight change since age 25 (lbs)	1.21 (0.12)[ab]	1.08 (0.13)[a]	1.39 (0.03)[b]
	Self-reported weight-10 yrs ago (lbs)	147.66 (2.1)	146.75 (3.32)	148.23 (0.96)
	Annual weight change over last 10 years (lbs)	1.25 (1.92)	1.28 (2.37)	1.46 (0.68)
	Weight change last 10 years (% of previous)	9.66 (1.32)	8.87 (1.45)	11.13 (0.41)
	Self-reported weight-1 yr ago (pounds)	162.55 (3.17)	158.28 (3.84)	162.65 (1.04)
	Weight change in last year (lb)	-0.69 (0.83)	0.91 (1.01)	0.8 (0.23)
	Weight change in last year (% of previous))	-2.38 (1.48)	1.23 (1.74)	0.19 (0.33)
	Self-reported greatest weight(pounds)	177.91 (3.3)	172.01 (4.61)	176 (1.22)
	Percent of heaviest weight	0.91 (0.01)[a]	0.93 (0.01)[ab]	0.93 (0)[b]

[1]Means with different superscripts indicate a significant difference at P<.05

Table 1. Differences in self-reported weight history data by cancer history.

Discussion

The impact of obesity on cancer risk has been studied to determine relationships between the various aspects of obesity-related cancers. One particular cohort study that examined the trends of colon cancer incidence in males with respect to anthropometric statistics, found a 2-fold risk for cancer with a weight higher than 87.4 kg (192 lbs) compared to those less than 73 kg (160.6 lbs) (5). This is alarming as our study confirmed that approximately one-third of Americans are overweight. Our data also indicated that the mean current weight of males in the non-obesity related cancer and no cancer history groups were both over the 87.4 kg. These individuals may be at risk of developing obesity-related cancers.

Weight fluctuations have also been shown to increase cancer risk. In a case-control study assessing weight changes with respect to renal cell cancer, women who have changed weight status more than three times have a 3-fold higher risk for cancer compared to women who have not meet this criterion (6). The criterion for weight change was an increase or decrease of 5 kg (11 lbs) from age 20. Our sample may reflect risks for this as females in the obesity-related cancer, non-obesity related, and no cancer history groups had weight gains of 12.48, 12.8, and 14.63 lbs. respectively, over the last ten years alone. Along with other possible weight fluctuations since the age of 20, this may put them at an increased risk.

Weight status and obesity not only has an effect in the occurrence of cancer, but may also contribute to its outcome. Trends between the outcome of breast cancer and weight changes showed a 2.5 greater occurrence of death from breast cancer in the heaviest weight group compared to the lowest weight group (7). The weights of these

groups were over 175 lb. and less than 133 lb., respectively. The females in our obesity-related cancer group had a mean heaviest weight of 177.91 lbs. Although the data from our study were cross-sectioned and only reflect one point in time, our findings may indicate an increased risk for cancer mortality among those with breast cancer in the obesity-related group.

A particularly powerful study in the New England Journal of Medicine by Calle et al. (3), found that patients who are overweight or obese that have cancer have an increased risk of death from their cancer. A significant positive association of BMI and all mortality from cancer was observed. The heaviest men and women, with a BMI over 40, had a 52% and 62% higher incidence of death from cancer, respectively, compared to those men and women of normal weight status (3). The ramifications of these data may describe the cancer mortality rates, as our data indicates that approximately one-third of the obesity-related cancer and no cancer history groups were obese.

Our study demonstrated numerous statistically significant differences despite having some limitations intrinsic to the secondary data. The weight data collected reflects individuals at various stages of life and health, such as newly diagnosed cancer, never diagnosed cancer, recovered and regaining weight. These differences make it difficult to provide an unbiased estimate of weight change across the three cancer groups we have assessed. It is also difficult to interpret all weight change values due to variability in length of time from diagnosis. For example, diagnosis could have changed in the past 10 years or 1 year which could shift the weight data. Weight fluctuations resulting from cancer treatments may alter the patterns of long-term and recent weight changes, decreasing our ability to detect differences in weight patterns and the

relationship with cancer history. Also, there may be errors within the weight history as it was self-reported by the participants.

Lastly, cancer does not have an identifiable marker to determine development in cross-sectional studies. To contrast, progression of other chronic diseases can be assessed using predictive markers. Cardiovascular disease can be easily examined through cholesterol, triglycerides, HDL, and LDL, while diabetes mellitus can look at insulin and blood glucose levels. This means that those with no cancer history may be at some stage of development or even exhibit the cancer without having a clinical diagnosis. Therefore, those with no cancer may reflect an absence of cancer history, but may include those who would later develop an obesity-related or non-obesity related cancer.

Even with these limitations, we found that males with obesity-related cancers over-estimated their weight to a greater extent than those with non-obesity related cancer. Men with no cancer history had significantly greater annual weight change since the age of 25 years of age and over the past 10 years than participants with previous cancer history. Also, men with obesity- and non-obesity related cancer histories were at a significantly lower percentage of the heaviest body weights than those with no cancer history. As for females, in the area of annual weight change in pounds since age 25, women with non-obesity related cancer history had a significantly lower annual weight increase than those with no cancer history.

Due to all of the published research, weight status and patterns are a critical part of the cancer process. It has been shown that adult weight changes can place an increased risk on individuals for cancer. This is problematic as our study has shown that men with no cancer history had significantly greater annual weight change since the age

of 25 and over the past 10 years than participants with previous cancer history. This may indicate that individuals without cancer currently are putting themselves at risk to join individuals already within the obesity-related cancer group. Also, data has shown that the higher the BMI of the individual, the greater the risk for a poor prognosis. This is alarming as our data indicates that sixty-eight percent of those with an obesity-related cancer history were overweight or obese at the time of measurement.

Further research is needed to elucidate the full effects of weight status and patterns on obesity-related cancer. One key aspect of the study should be to assess weight status and patterns at specific points in the cancer process such as before or at time of diagnosis and treatment. This will allow for better analysis of the results and comparisons across groups.

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